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THE JOURNAL
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THE LURE OF UNDERGROUND TREASURES*

By LACHLAN GILCHRIST

WE may think of these treasures as falling into two classes:

(1) The commercially valued ore from which we obtain the precious metals such as gold, silver, platinum, uranium and radium, the base metals such as lead, zinc, tin and copper; or the useful minerals, gas, oil and coal. In Canada such treasure is largely buried under a cover of water, alluvial deposits or glacial sediments.

(2) The large and rapidly increasing body of organized information on the physical and chemical properties of the earth, on its geological structure and on its function as a member of the Universe.

The nature of these treasures differs widely. The lure of the first treasure is in general the impelling attraction to many men to search out and mine the treasure and thus to acquire wealth and an enlarged sphere of living. To some men, however, the lure of the second treasure dominates. It becomes the elusive objective that inspires research aimed at extending the boundaries of knowledge, truth and power. The indulgence of this yearning for investigation is a great treat but in general an expensive one.

I. THE MATERIAL TREASURE UNDERGROUND

The type of search for the treasure has varied from the mystical methods of the divining rod to the laborious and meticulous gathering of evidence in strictly scientific ways. The end result, or the

*An address to the R.A.S.C., Guelph Centre, Thursday, Nov. 11, 1948. (Abbreviated).

"find", has always been the measure of the adequacy of the method. But usually the statistics of successes and failures are not fully recorded. The searcher naturally attaches more weight to the successes, and the failures are quickly forgotten. This is true of all methods of search. A survey of the efforts to locate gold mines in Ontario and Quebec between 1900 and 1940 shows that over 15,000 companies were formed for this purpose but that only about 90 were successful in finding gold in commercial quantities and about 70 have paid dividends.

It is evident then that room for extensive improvement exists. It is perhaps obvious also that improvement must come by intensive quantitative research on all of the physical properties and principles that form the background of all methods. In this respect the method of the divining rod has received little or no attention. For evaluation it has depended largely on assertions of success or failure by the operators.

Previous to 1919 scientific methods of search for minerals depended almost entirely on geological evidence as gathered by field investigations on outcrops or on the results of trenching, drilling or drifting, and on laboratory studies of rocks and minerals. The extensive cover of sand, clay, gravel, muskeg and water made field investigations difficult; and trenching, drilling and drifting were very expensive. Nevertheless considerable progress was made in collecting and organizing geological evidence and an increase in discoveries followed. However, the results of the 1900-1940 survey indicated the imperative necessity for increasing the scope of evidence on which mining activities are based. Efforts in this direction had been commenced on this continent in 1919 and the results which were obtained in the second half of the period of the survey, i.e., 1920-1940, indicate an increase in successful exploration in Canada. There was an even greater increase in Europe and in the United States.

To a considerable body of this new information has been given the name *geophysical evidence*. It is obtained from quantitative measurements in the field on the physical properties of rocks and minerals and on the cover of water and sediments in place, as well as from investigations in the laboratory on the physical properties of specimens of the various materials. Among the physical properties that have been under investigation are:

(a) The magnetic properties of such materials as magnetite, pyrrhotite (nickel ore), ilmenite (titanium ore).
(b) The electrical conductive properties of all the materials.
(c) The electrical battery or generating properties chiefly of soluble mineral sulphides.
(d) The densities of all of the materials.
(e) The velocities of transmission of explosive waves through all of the materials, and the properties of reflection and refraction of these waves by the materials.
(f) The temperatures and heat capacities of the materials.
(g) The radiation properties of certain of the minerals such as Radium, Uranium and Thorium.

Geophysical methods of exploration based on these properties bear characteristic names, viz., Magnetic, Electric, Gravitational, Seismic, Thermometric or Radioactive Methods.

Geophysical methods of exploration were brought into Canada, especially into Ontario and Quebec, about 1925 by commercial companies having their origin in Europe or in the United States. Claims of successful exploration by these companies were received by many of those already engaged in exploration by other methods, with disbelief and misgiving. Antipathy between the old and the new explorers became intense. This was shown in a very much disturbed meeting of the Canadian Mining and Metallurgical Society at Quebec in February of 1928, where the discussion on the geophysical methods terminated in bitter dispute among many of the geologists and geophysicists present.

It was then that the late William Henry Collins, director of the Geological Survey of Canada, which office he held for many years with credit and distinction, decided that it was the duty of the Survey to endeavour to determine the merits of the new methods. To this end Dr. James B. Mawdsley, geologist and the writer were asked to make an investigation into the methods of the various companies operating in Canada. Dr. Collins's decision to make this investigation did not meet with the hearty support of several of his own staff; for, of course, money spent on this effort came from the Survey's limited appropriation and it might decrease the amount available for other projects. The summer of 1928 was spent in this investigation in the region of the Old Abana Mine, now the Normetal Mine, some fifty miles north of the Noranda Mine, a region having such a varied set of rock, mineral and cover conditions as to

make it quite suitable for a definite tests of the methods used by the various companies. The willingness of the geophysical companies to send their equipment and men to such a remote district was evidence in itself of their confidence in their own methods.

The investigation brought to light certain very definite results:

1. The methods in general had very distinct merit with, however, inherent weaknesses and inadequacies.
2. Geophysics appeared to be a very desirable and suitable subject for study, research and development by staff and students of the University of Toronto.
3. The very large area of swamp- or sediment-covered territory in Canada in which the outcropping of rocks is almost entirely absent precluded the usual geological methods of exploration in many districts and made the development of geophysical methods highly desirable as an aid to discovery and to the growth of the mining industry.

Since 1927 therefore a considerable part of the writer's spare time and effort has been devoted to the study and development of geophysical methods in the field and in the laboratory. Of necessity, this gave rise to the introduction of geophysical problems in the curriculum of the University of Toronto and to the training of capable students to engage in field work with geophysical exploration parties or to undertake problems of geophysical research.

In the past few years geophysical research and the training of students at the University has been greatly extended. A separate building has been set aside and remodelled and equipped with instruments and facilities to serve as a geophysical institute. Three full-time members of the staff in geophysics with several part-time assistants have been appointed. Loans and scholarships have been provided for capable promising students. Through this effort it is hoped that considerable benefit may accrue to the mining industry of Canada. It may, let us hope, assist in developing the spirit of research in students and in the personnel engaged in Canadian industry in general. Indeed it may help to stem the tide of able graduate students who now pour into other countries, or even stimulate a return flow to Canada. The development of research and of production is at this time urgent, for Canada has now become of world wide interest, and she must direct her efforts in such a way that her growth may not be impeded.

In the past twenty-five years geophysical research in Canada,

in the British Empire, in Europe and in North and South America has grown apace. Under state supervision it has been greatly extended. In Canada the regions of exploration in the field now extend from Great Bear Lake in Northwestern Canada to Labrador in the east and from the United States border almost to the North Pole. Private enterprise on this continent, especially in the United States, has also undertaken research and exploration on a rapidly growing scale, and, with efficiency and expansion in mind, many millions of dollars are spent monthly in the United States on fundamental as well as applied research in geophysics. It is apparent also that Canadian mining industry is well on the way to follow this lead

The recent war gave a great impetus to this trend and one example will serve to illustrate this. About twenty years ago the Research Laboratory of the Western Electric Company, a subsidiary of the American Telegraph and Telephone Company, undertook an extensive research on magnetic alloys, primarily for use in overcoming difficulties in telephone transmission, in the operation of electric valves and amplifiers, and in broadcasting. (Other industries, e.g., the Radio Corporation of America and General Electric Co., also engage in similar research.) A large number of magnetic alloys were produced by the Western Electric Company, some even without iron as a constituent, and these alloys have received many useful applications. Some very useful alloys were given the name *permalloy*. These were alloys of nickel and iron, of compositions varying from 30 to 90% of nickel, and some of them contained also small quantities of chromium and manganese or other metals. Several of these alloys had the unique property of becoming strong magnets under the influence of very weak magnetic fields, and of instantly losing their magnetism when the exciting magnetic field was removed. In the field of telephonic and radio communications these alloys have been widely applied

With the advent of war the uses of these alloys were greatly extended. While engaged on the problem of the detection of submarines and underwater mines, a member of the research staff of the Gulf Oil Corporation at Pittsburgh Mr. Valquier, suggested a method of using permalloy as a submarine detector which in 1944 proved very effective. A cylinder of permalloy was made the core in the primary of a small transformer and the secondary coil contain-

ed many turns of fine wire. The instrument was suspended about 100 feet below an aeroplane. A rather weak alternating current was sent through the primary coil and a comparatively high-intensity alternating current was produced in the secondary coil and was shown on the indicator in the plane. When the suspended transformer passed over a submarine lying hidden beneath the surface of the ocean the permalloy core and the suspended transformer turned directly toward it and the core became strongly magnetized. This took place because the magnetic field in the neighbourhood of the submarine was stronger than the normal magnetic field of the earth. The alternating current in the secondary of the transformer was thus increased in intensity and this increase was transmitted to the indicator in the plane. Depth charges were immediately used; and in the summer of 1944 some enemy submarines went to their destruction. In this way the results of peace-time research served usefully in breaking the back of the war menace of submarine attack. This instrument of the war, now called the air-borne magnetometer, has found a very useful application in geophysical exploration. In Ontario and Quebec many of our minerals are intrusives or extrusives in the fissures, or disturbed conditions, in the Precambrian shield. Metamorphosis, or alteration, of the rocks in these fractured or sheared regions has often resulted in iron formation containing some magnetite. Well-arranged systematic parallel profiles from north to south are made by the plane carrying the air-borne magnetometer, and the indicator record of the instrument together with the position of the plane locates the disturbed regions in the rocks, or perhaps gives direct information of the existence and location of magnetic ore-bodies. To these localities the geophysical prospector is thus directed to carry out more detailed investigations on the surface of the ground in the search for the precious or base metals or even for oil, for in the last few years the usefulness of magnetic methods as an auxiliary method of exploration for oil-containing regions has become recognized. Hitherto these scouting explorations were made on the surface of the earth by means of the miner's dip-needle or by the much more sensitive and rugged magnetometers developed in Sweden and Germany.

Considerable air-borne magnetometer exploration has been carried out during the past two years in Canada and the United

States and great speed is exhibited in obtaining good results. Similar magnetic scouting exploration made on the *surface* of the earth is, of course, comparatively slow. In a northern Ontario region during the year 1946 a party under the writer's direction carried out thirty-eight miles of scouting magnetic exploration in a little less than two months of work. An air-borne magnetometer would have obtained similar results in a few hours.

II. The Lure of Scientific Research

There is great satisfaction in applying the laws of physics, especially of magnetism and electricity, to investigate the nature and condition of the materials beneath the surface of the earth. The writer has been engaged on several researches of this sort. The work is very technical and only a brief account of what has been done can be given here.

In carrying on magnetic investigations in the field the following assumptions are made:

1. There is a primary, or normal, magnetic field of the earth, which is assumed (by P. S. M. Blackett and others) to have been produced by the rotation of the earth, or is postulated (by E. C. Bullard) to be due to convection currents in the liquid metallic core of the earth.
2. The actual form and intensity of the magnetic field at any place is largely due to the presence of massive anomalous magnetic materials in the earth's crust in the neighbourhood. These materials modify the values of the components of the field-intensity, and the magnetic dip at the place.
3. There are two classes of anomalies, (a) Those which contain numerous small but finite magnets and can be represented by an equivalent magnet. Such are composed of magnetite, pyrrhotite, ilmenite, &c. (b) Those differing in magnetic permeability but having no finite magnetic poles; such as water, oil, dolomites.

An investigation of some typical examples of anomalies of class (a) is presented by the author in the *Canadian Mining Manual* for 1945. In the article is given the procedure for locating the anomalous body and the method of determining the depth, dimensions, dip, and an average intensity of magnetization of the equivalent magnet.

Reference may be made to another 'magnetic' research of a somewhat different type which is in progress in the Geophysical Laboratory of the University of Toronto. It is entitled "An Investigation on the Magnetic Properties of rocks and cores in solid and powdered form", and was undertaken with the aid of a grant from

the National Research Council of Canada. In carrying it out the writer has been assisted by B. W. Robinson, E. B. Manchee and F. A. Macpherson, students in geophysics in the University.

Specimens of cores and rocks have been supplied by various mining companies but those from the McLeod-Cockshutt mines have been more fully investigated. Among the latter were three specimens of magnetite 15.2 cm. (6 inches) long obtained at a depth of 340 feet in the same south-north vertical plane, one from a horizontal hole drilled from south to north, the second from a hole drilled from south to north at a dip angle of 70°, and the third from a hole drilled from north to south at a dip angle of 70°.

By experiment it was found that the magnetic properties of the three samples differed greatly among themselves and by combining measurements upon them it was possible to determine the true dip of the exciting field of the earth at a point 340 feet below the surface at the McLeod-Cockshutt Mine. This angle of dip is approximately 68°. Magnetic maps give the dip on the surface as 78.5°. By obtaining the dip at various depths below the surface and also the true declination at these points, it is hoped to determine the depth of the north magnetic pole of the earth.

In this research also an effort is being made to compare the actual and the possible magnetic moments of the cores and of their constituent magnetic materials. Specimen cores of highly concentrated magnetite were obtained from a vertical hole near Clinton, N.Y., and similar cores of much less concentration of magnetite from a vertical hole at Milton, Ontario. In each case the magnetic moment per unit weight per unit concentration of magnetite along the magnetic axis of the specimen was determined. The specimens were then ground to a fine powder and again made into a magnet under an exciting magnetic field comparable to that of the earth. The magnetic moments for the re-made specimens differed according to the region from which the materials came, and also the ratio of these magnetic moments to the magnetic moments of the original specimens.

The electrical resistance offered by a substance to the passage of a current through it is a distinguishing property of that substance. Generally speaking, the metals have low resistance, while in rocks and organic substances it is high. If a difference of electrical potential be applied to two points on the earth's surface, say some feet apart,

the current, or electric impulses, will enter at one point (the *source*) and will spread out and go by different paths to the other point (the *sink*). These paths will differ according to the specific resistance, or *resistivity*, at each point of the material. It is pretty evident that if we could determine the resistivity at various points of a massive body below the surface of the earth we should be able to deduce information regarding the nature and size of the body. The solution of a problem of this sort has some complications and difficulties, but the object we seek is of great value and so worthy of the attempt.

In the search for commercially valuable minerals in northern Ontario and Quebec single drill holes have been used for placing the electrical source far down in the medium, and four similar *equal* sinks have been placed on the surface of the ground symmetrically arranged with respect to the source. By means of switches the current may be sent in each of the four directions and suitable comparison made. For the simple purpose of electrically "logging" the hole, i.e., to determine the variation of the resistivity along its length, all four of the *equal* sinks may be used together. One sink only is sometimes used and is placed near the upper entrance of the hole. When using a pair of drill holes, the source was placed in a fixed position near the bottom of one hole and the sink was placed in successively deeper positions in the other hole. Divergences from homogeneity in the mass being investigated were clearly shown.

A number of drill holes have been employed, singly and in pairs, and extensive information has been obtained on the distribution and structural arrangement of the sub-surface material. This method of exploration is rapidly becoming standard practice by geophysical exploration companies.

In connection with the magnetic investigations the writer gratefully acknowledges the assistance of the geologists of the Little Long Lac and McLeod-Cockshutt Mines and of Professor G. H. Langford. The electrical field investigations were largely carried out by the staff of Aldermac Copper Mines in co-operation with graduate students A. R. Clark, J. W. Britton and M. J. Innes.

Detailed technical papers on the research work referred to in the immediately preceding paragraphs are now completed and it is expected that they will be published shortly in suitable journals.

SIMULTANEOUS OBSERVATIONS OF SOLAR RADIO NOISE ON 1.5 METERS AND 10.7 CENTIMETERS

By A. E. Covington and W. J. Medd

ABSTRACT

Simultaneous solar noise bursts on 1.52 meters and 10.7 centimeters have been recorded with a chart speed of one and one-half inches per minute. The longer wavelength noise bursts show many rapid fluctuations, as contrasted with a smooth rise and fall on the shorter wavelength.

THE emission of radio-frequency energy or "solar noise" from the sun, may be observed over a range of wavelengths varying roughly from fifteen meters to one centimeter.[1] For the past few months, at the National Research Council, Ottawa, solar noise has been recorded simultaneously on 1.5 meters and 10.7 centimeters. In the neighbourhood of these two wavelengths the characteristics of the radiation received are very different.

The radiation on wavelengths of one meter or longer has its origin in the corona, and at 1.5 meters the quiet sun has an equivalent temperature of about 10^6°K. This value is in agreement with the temperature found from considering the high excitation of iron in the coronal spectrum. For wavelengths of the order of ten centimeters, the corona is partially transparent, and the radiation, which has an equivalent temperature of 8×10^4°K, originates predominantly from a lower and cooler layer of the solar atmosphere. At still shorter wavelengths, the temperature decreases further, until at 1.25 centimeters the observed equivalent temperature of 10^4°K is close to the 6000°K optical temperature of the photosphere.

The intensity of the solar emission varies with the appearance and disappearance of sun spots. On 10.7 centimeters, this variation is about two and one-half times the quiet sun level,[2] and has a coefficient of correlation $= 0.76$, with the sun spot area fully corrected for foreshortening.[3] On meter wavelengths the intensity variations are more extreme and the day-to-day fluctuations are more rapid. The observations of Ryle and Vonberg on a wavelength of 1.71 meters have indicated values of one hundred times the quiet sun level,[4] and although in this region there is no direct correlation with sun spot area, there is a strong increase in noise when a sun spot is located near the solar meridian.

Bursts of solar noise on meter wavelengths, lasting from a few seconds to several minutes, may occur as frequently as fifty per hour. Individual bursts of moderate amplitude have not been associated with any disturbance on the sun's disk as viewed with the spectrohelioscope; but the larger bursts or outbursts, which are an exception, show some tendency to be associated with solar flares.[5] On a wavelength of 10.7 centimeters, the bursts are much more infrequent—one every few days—and show a strong tendency to be associated with solar flares, if the occurrence of a sudden ionospheric disturbance can be taken as an indication of a solar flare.[3]

The 10.7 centimeter receiver in operation at the National Research Council, Ottawa, is fed by a parabolic reflector with a dipole at the focus. It has a cone of acceptance of 6 degrees to the half-power points, and is motor-driven to automatically follow the sun during the course of the day. The radiometer accepts two frequency bands, four and one-half megacycles wide, centered at 2830 and 2770 megacycles.

The antenna of the 1.52-meter receiver is a five-element Yagi with a beam width of 55 degrees to the half-power points. Thus radiation is accepted over an area too wide to permit accurate cali-

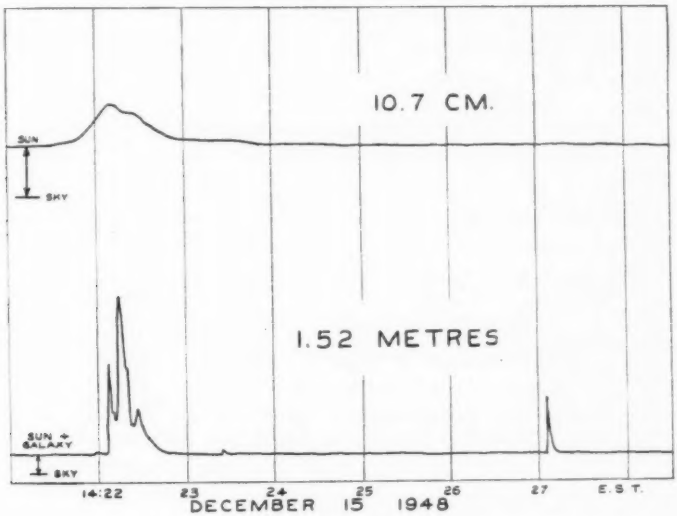

FIG. 1

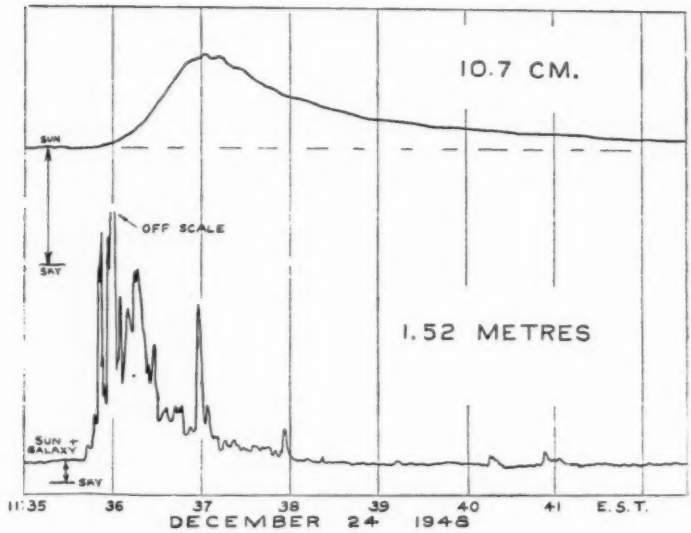
10.7 CM.
SUN
OFF SCALE
SKY
1.52 METRES
SUN + GALAXY
SKY
11:35
36
37
38
39
40
41
E.S.T.
DECEMBER 24 1948

FIG. 2

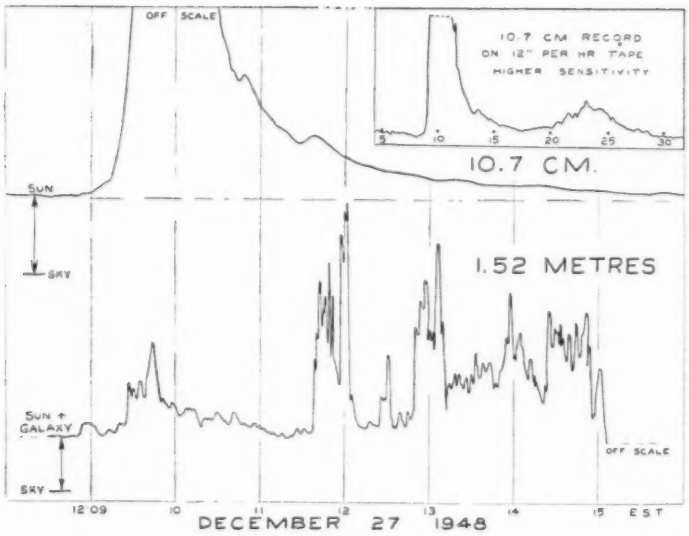
OFF SCALE
10.7 CM RECORD
ON 12" PER HR TAPE
HIGHER SENSITIVITY
5
10
15
20
25
30
10.7 CM.
SUN
SKY
1.52 METRES
SUN + GALAXY
SKY
OFF SCALE
12:09
10
11
12
13
14
15
EST
DECEMBER 27 1948

FIG. 3

bration of the set. The orientation of the antenna is adjusted manually. The radiometer accepts a band of frequency four megacycles wide, centered on 197 megacycles. The output of each radiometer is used to drive an Esterline-Angus meter, recording with a chart speed of one and one-half inches per minute. The time constant, defined as the time required for the meter in response to an input step function to attain 63 per cent of the maximum deflection, is respectively one-half second and one second, for the 1.52-meter and 10.7-centimeter radiometers.

Eight records of simultaneous noise bursts on 1.52 meters and 10.7 centimeters have been obtained, of which three are shown in the accompanying figures. On December 15, 1948 (see figure 1), the 10.7-centimeter noise burst precedes the long wavelength noise by about 35 seconds. During this burst no sudden ionospheric disturbance was recorded on the circuit from radio station WWV, Washington, to Ottawa. Figure 3 shows the same tendency of the shorter wavelength burst to precede, although in this case there is some minor activity on the longer wavelength at the start of the ten-centimeter burst. A sudden fade-out of the WWV signal was observed at 12^h10^mE.S.T. ($\pm$ 1 minute). In both figure 1 and figure 3 the main activity on 1.52 meters occurs during the decline of the 10.7-centimeter burst. A similar time relationship was observed during a second burst on December 27, 1948, beginning at 14^h35^mE.S.T.

Associated with the bursts on December 24, 1948 (see figure 2), the ionospheric fade-out as recorded at Ottawa began at 11^h34^mE.S.T. ($\pm$ 1 minute) and declined gradually to a minimum at 11^h37^m. As closely as can be discerned, the bursts begin at the same time on the two different wavelengths. Another example of very close coincidence in time was recorded in connection with a small 10.7-centimeter burst beginning at $15^h04^m55^s$ E.S.T. January 3, 1949; but no case has yet been observed in which the 1.52-meter burst definitely precedes. On several occasions, however, there have been comparatively large bursts of energy on 10.7 centimeters, while the solar radiation on 1.52 meters showed no appreciable increase. A similar example has been reported by Lehaney and Yabsley, who recorded simultaneously a large burst or outburst on both 50 and 25 centimeters, concurrent with only mild solar activity on meter wavelengths.[6]

As previously implied, there are innumerable occasions when the

intensity of solar radiation fluctuates over a wide range at 1.52 meters, but remains quite steady at 10.7 centimeters. A good example of this occurred on December 10, 1948, when three well isolated bursts were observed on 1.52 meters at approximately 12^h50^m, 12^h54^m and 12^h57^m E.S.T., of which the third alone was associated with a burst on 10.7 centimeters. The more complex character of the noise and the more rapid changes of intensity on the longer wavelengths, as contrasted with the smooth rise and fall of the 10.7-centimeter bursts, is quite general.

Radio and Electrical Engineering Division,
National Research Council,
Ottawa, Canada.
10 February, 1949.

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REVIEW OF PUBLICATIONS

Skalnate Pleso Atlas of the Heavens, by A. Becvar. Pages 17; 23½ × 15½ in.; unbound. Sky Publishing Corporation, Harvard College Observatory, Cambridge, Mass.; 1949. Price $5.00.

Throughout the history of astronomy there have been constructed and printed a number of excellent charts of the sky, and since these charts suffer little from obsolescence, it might be thought that all the charts necessary for amateur and professional astronomers might be in existence. It is true that the splendid Norton's *Star Atlas and Telescopic Handbook* serves both classes of astronomers very well for many purposes; it is now in its tenth edition and it is usually obtainable. Norton's *Atlas* records stars approximately to the naked-eye limit, as well as many telescopic objects of interest. Beyond this atlas is the famous Argelander's *Atlas,* or the B.D. charts, produced during the 19th century, which records stars to the 10th magnitude. This is available at observatories and large astronomical libraries, but it is not available to most amateurs. Between Norton and the B.D. there was, for a long time, no really good all-purpose chart. The need was partly filled in 1940 by publication of Webb's *Atlas of the Stars,* which has been of particular value to variable star observers. This atlas records stars down to 9th magnitude for the northern and some of the southern sky. It is of a handy size and it is bound; but the portion of sky represented per page is small. Now, in 1949, by the publication of the *Skalnate Pleso Atlas of the Heavens,* there becomes available another addition to close the gap between Norton and the B.D., which, though unbound and of a distinctly unhandy size, has the advantage of presenting a large portion of the sky per sheet, so that the familiar star figures remain recognizable.

Skalnate Pleso, meaning Rocky Lake, is the name of a new astrophysical observatory in Czechoslovakia. Its director, Dr. Antonin Becvar, favouring an idea originating with the well-known Czechoslovakian amateur astronomer, Josef Klepesta, undertook, with the assistance of a group of volunteer assistants, to produce

an atlas to fill the long-felt need. After 3,000 man-hours of work they published in Czechoslovakia in 1948 the *Skalnate Pleso Atlas of the Heavens*. Shortage of paper restricted the original printing very seriously, but now, through the new printing by the Sky Publishing Corporation, the *Atlas* is in good supply.

The *Atlas* covers both hemispheres with 16 charts. There are six charts of the equatorial regions on a rectangular graticule, each covering declinations from $+25°$ to $-25°$; there are four charts for each hemisphere with straight, converging hour circles and concentric, equally-spaced, declination circles, covering declinations from 20° to 65°; and there is, for each hemisphere, a circumpolar chart covering from declination 65° to the pole. All stars down to visual magnitude 7.75 (32,571 in number) are shown, the magnitudes being represented by the sizes of the filled circles ranging from small dots to circles of nearly ¼-inch diameter. Double and multiple stars are clearly identified, and visual binaries are differentiated from spectroscopic binaries. All known variables, including novae, which have had maxima brighter than magnitude 7.75 (443 in number) are identified. 249 Clusters are shown as to position and relative size. All globular clusters are shown. 1,130 Extragalactic systems are shown as to position and size, as are also many planetary, diffuse and dark nebulae. The Milky Way, the I.A.U.-endorsed constellation outlines, the equator and the ecliptic are all shown. Positions are for the epoch of 1950.

A legend in Latin is given in the left-hand margin of each sheet. No one need be alarmed by the Latin, for the terms are almost identical with the English terms, and, in any event, there is an introductory page in English telling the history of the charts and describing their form.

The charts present a pleasingly clean and neat appearance that makes it difficult to believe that they contain as much information as they do. For telescopic study of star fields, for identification of variables, for comet searches and for many other purposes one could hardly wish for a nicer set of charts.

The new atlas, ranking third in size in the existing literature, will be of very great value indeed to professional astronomers; and for the more ambitious amateurs who have begun to feel the limitations of less extensive charts and atlases, it is difficult to imagine

a more welcome addition to the literature—especially in view of its availability and its moderate price.

J. F. H.

Gnomonicky Atlas Hvezdne Oblohy, edited by V. Guth. Pages 17; 50 × 50 cm.; unbound. Czechoslovak Astronomical Association, Prague; 1940.

In 1938, at the Stockholm meeting of the International Astronomical Union, Dr. V. Guth of the National Observatory at Prague presented to the Commission on Meteors a sample chart of a Gnomonic Star Atlas prepared by the Meteor Section of the Czechoslovak Astronomical Association. The Commission recommended that the charts be published as soon as possible. Apparently these charts were published in the form of an Atlas in 1940, but only recently has a copy reached the David Dunlap Observatory.

The Atlas, which was designed particularly for meteor observers, consists of 14 charts which cover both hemispheres of the sky. The stars shown number 7,796 and reach to magnitude 6.5. No key star figures or constellation boundaries are shown, and the range of sizes of the circles representing the stars is rather small, so that it is a little difficult to find the familiar groups. For general purposes this limits the usefulness of the Atlas.

Since meteor paths are great circles in the sky, and since the gnomonic projection represents great circles as straight lines, these charts have been drawn on this projection. There is one polar gnomonic chart for each circumpolar region down to declination 40, and, for each hemisphere, there are six oblique gnomonics centred at declination 30. No graticules are printed on the charts, but two reticules, printed on transparent paper are supplied. One of these is a graticule which fits any of the 12 equatorial charts, so that coordinates may be estimated. (None is needed for the polar charts.) The other reticule is for measuring great circle arcs on any of the charts. Instructions in English are given for using these reticules. These devices make the charts very useful for observation and calculation of meteor paths and for certain other purposes.

J. F. H.

Human Knowledge: its Scope and Limits, by Bertrand Russell. London: Allen and Unwin: N.Y., Simon & Shuster, 1948, $5.00.

In his book "The Observational Approach to Cosmology" Hubble has put a striking caption to an astronomical photograph of stars and nebulae; he has called the photograph "A sample of the Universe". Perhaps Bertrand Russell is referring to this in his recently published book, for he writes:

> "Hundreds of thousands of years ago, a vast and remote region emitted incredible numbers of photons which wandered through the universe in all directions. At last a very few of them hit a photographic plate, in which they caused chemical changes which made parts of the plate look black instead of white when examined by an astronomer. This tiny effect upon a minute but highly educated organism is our only reason for believing in the existence of a nebula comparable in size with the Milky Way."

The purpose of Russell's book is to explain and justify the process by which we make this inference, from the grains on a photographic plate, of a teeming universe of stars, and all the similar inferences which make up what we call scientific knowledge.

The starting point of Russell's analysis is *perception,* which is what happened to Hubble when he looked at the plate. Knowledge at its lowest level is very closely related to such perceptions. In a limited sense, Russell shows, animals as well as humans have knowledge and belief. Such knowledge is pre-verbal, and is part of the stuff of immediate consciousness. This knowledge is not a clearcut thing, but shades into different degrees of uncertainty and Russell is at pains to show that a degree of uncertainty persists in the greatest refinement of knowledge of which we are capable.

The introduction of language makes for a great increase in the efficiency with which we deal with experience. It makes it possible for men to claim knowledge which they have not experienced, in the sense, for example, that I "know" of Napoleon. But language also presents certain problems, mostly technical, which Russell deals with in great detail. His purpose is to examine what are the minimum vocabularies necessary for a given branch of science, i.e., the minimum number of terms not defined logically; and the process, often elaborate, by which very complex ideas can be expressed by the minimum vocabulary.

As science develops, the minimum vocabularies become smaller (contrary to what one might think). For example, at some time in

the XVII Century one redefined "Mercury" as "The planet nearest the sun". Carried out to completion "the sun" remains a part of the minimum vocabulary for descriptive astronomy and (I quote) "we shall need what is necessary for defining celestial coordinates . . . some other heavenly body to fulfil the function which Greenwich fulfils in terrestrial geography. In this way official astronomy could get on with (it would seem) only two proper names, "the sun" and (say) "Sirius". The Moon, for instance, can be defined as "the body whose coordinates on such-and-such a date are so-and-so." (End of quote). To this system one must add two propositions, namely "this is the Sun" and "This is Sirius" to complete an education in astronomy.

As an example of definition I offer Russell's definition of "truth" and "falsehood":

> "Every belief which is not merely an impulse to action is in the nature of a picture, combined with a yes-feeling, or a no-feeling, in the case of a yes-feeling it is "true" if there is a fact having to the picture the kind of similarity that a prototype has to an image; in the case of a no-feeling it is "true" if there is no such fact. A belief which is not "true" is called "false".

Having analyzed the verbal foundations of science Russell proceeds to consider the structure of the world. He believes that the world exists, and that we have knowledge of it. The problem is that the end-product of science is so different from anything we would have imagined before the development of science that we are constrained to ask: is science true? And if it is true, how can we know it to be true? Russell argues that the seemingly abstract ordering of events in physics is causally related to our perception. Things which I see close together are (with certain reservations) close together in space-time. If I perceive event A before event B there is a corresponding ordering of events in space-time. And in general there is a causal chain connecting my private world of reds and browns and blacks with "the world" of physics—electromagnetic vibrations and the so-called fundamental particles. This requires me (i.e., my body) to submit to these laws. Russell holds that in principle the behaviour of my brain probably could be explained by the laws of physics without additional hypotheses. The universe as seen by Russell is on the human scale. There is no cowering before the 'great silences'.

Finally, the most difficult section of Russell's book is concerned

with discussing how we may be justified in believing such a proposition as "The Sun will rise tomorrow". Russell says he is not asking whether this belief is true, but what, assuming it true, are the best reasons for believing it. Generally: why should we believe things asserted by science but not verified by present perception? The answer, Russell feels, is by no means simple. The belief that the sun will rise to-morrow precedes the scientific demonstration that it will rise. This induction is based on the fact that its rising has been observed many times before. In general, we expect an event which has occurred in a given situation many times to occur when the situation arises again. For example, if a star has been observed to vary in a regular cycle for some time in the past, we expect it will go on doing so in the future, and with the more confidence the longer its behaviour has been established. Russell holds that this inference is non-deductive, i.e., that it cannot be shown by logic alone. Nor can it be shown by experience, since to-morrow's event cannot be experienced now. Thus scientists employ a principle which is not given in experience or logic. Russell holds that there are others, and makes a tentative description of them. This part of Russell's book is controversial, and this reviewer does not feel competent to comment, save to remark that these admissions might be used against Russell's own position by hostile critics.

This book is a development of the point of view of Russell's "History of Western Philosophy" and shares with that work the strong easy prose style, and the wonderful power to treat difficult and complicated ideas lucidly. Hostile alike to dogma and scepticism, it is a reasoned account for reasonable men. It is in the great liberal tradition, come of age in the twentieth century.

R. L. Baglow

OUT OF OLD BOOKS

By Helen Sawyer Hogg

Jean Sylvain Bailly, The Guillotined Astronomer.

TO be remembered by the historians, but forgotten by the astronomers, is the twentieth century fate of the French astronomer, Jean Sylvain Bailly, 1736-1793. Probably no astronomer who ever lived has played a more important role in the shaping of his country's political destiny. Small wonder it is, then, that the political aspect of the last years of his life has, in less than two centuries, overshadowed the fact that his earlier years were devoted successfully to science, in particular to astronomy. Jean Bailly is not to be confused with the English astronomer Francis Baily (Baily's beads), who lived a half century later and appears better known to-day, at least on this continent.

A vivid general picture of Bailly's dramatic career is given by St. A. Berville in the *Collection des Mémoires relatifs à la révolution française* 1821. We give a translation of the opening paragraph of this account, Mémoires de Bailly.

> A noble and touching picture to present to posterity, is that of a man who, already celebrated in the sciences, recommended by all the private virtues, finds himself, almost unwittingly, carried by public esteem to eminent functions; maintains his modesty in the midst of highest dignities, his moderation in the midst of the most violent political dissensions; goes through an outrageous revolution without letting himself be swept along with it; associates with all its glories, remains free from all its excesses; defends liberty against power and power against licence, and crowns the life of a sage with the death of a hero. Such was Sylvain Bailly, first deputy of Paris to the States-General, first president of the Constitutional Assembly, first Mayor of Paris.

Bailly was born September 15, 1736, at the Louvre, where his father was keeper of the king's paintings, an hereditary position which was intended to be passed on to young Jean. His early training was in this direction, but his own inclination was toward more literary pursuits. Indeed, one curious circumstance of his life is that at the age of sixteen he composed a tragedy, Clothaire, which related the tortures inflicted on a mayor of Paris by a deluded multitude—almost a prophecy of the ending of Bailly's own life.

Through his friendship with the celebrated Lacaille, Bailly early became interested in science, and devoted his labours to it. His first astronomical work was a calculation of the comet of 1759, that is, of Halley's comet on its first predicted return. Possibly as a result of the enthusiasm engendered by the return of this famous comet, Bailly established an observatory in his place of residence, the Louvre, in 1760. The observatory apparently consisted of a window in the upper story of the south gallery, with a few instruments. At this time France did not possess a first-rate observatory. The earliest observations made by Bailly are dated in the beginning of 1760, when he was not yet twenty-four years of age, and are of an opposition of Mars. In the same year he determined oppositions of Jupiter and Saturn.

In 1761 he was associated with Lacaille in observations of the transit of Venus (cf. this JOURNAL, vol. 41, p. 321, 1947). The decade from 1759 to 1769 must have given a great impetus to astronomy, bringing as it did the return of Halley's comet, and the occurrence of a pair of transits of Venus, an event so rare that we in the twentieth century will never witness one. Bailly calculated the parabolic orbit of the comet of 1762; he discussed 42 observations of the moon by La Hire, a starting point for lunar theory. In 1763 he published a reduction of observations made by Lacaille on zodiacal stars and in 1764 he competed for a prize offered by the Academy of Sciences for a dissertation on the theory of Jupiter's satellites. Lagrange was the successful competitor on this occasion, but Bailly's paper established his reputation as an astronomer.

During these years he became known for his elegant literary style in the composition of eulogies of a number of important men. As a result of his ability in several fields he had the almost unique distinction of being elected to all three French academies, a distinction which had previously befallen only Fontenelle. He was elected to the Academy of Sciences in 1763, to the French Academy in 1784, and to the Academy of Inscriptions and Belles Lettres in 1785.

Bailly devoted a large share of his astronomical life to the writing of astronomical histories and researches in the history of the science. His most extensive work was a history of astronomy, the first volume of which, *Histoire de l'Astronomie Ancienne*, was published in 1775. Three volumes, *Histoire de l'Astronomie*

Moderne, followed in the years 1776-1783. In 1787 his final historical volume was published on Indian and Oriental astronomy, which was a mixture of erudition and fantastic speculation.

It is recorded by Arago, *Biographies of Distinguished Scientific Men*, tr. by Smyth, Powell, and Grant, p. 77, 1857, that

> In 1775, Bailly sent the first volume of his history to Voltaire. In thanking him for his present, the illustrious old man addressed to the author one of those letters that he alone could write, in which flattering and enlivening sentences were combined without effort with high reasoning powers. "I have many thanks to return to you (said the Patriarch of Ferney), for having on the same day received a large book on medicine and yours, while I was still ill; I have not opened the first, I have already read the second almost entirely, and feel better."
>
> Voltaire, indeed, had read Bailly's work pen in hand, and he proposed to the illustrious astronomer some queries, which proved both his infinite perspicacity, and wonderful variety of knowledge.

The force and charm of Bailly's writings are typified by the opening paragraph from the *Histoire de l'Astronomie Ancienne.*

DISCOURS PRELIMINAIRE

De l'objet de l'Astronomie, de la nature de ses progrès et de son utilité.

L'histoire de l'Astronomie est une partie essentielle de l'histoire de l'esprit humain. Cette science née dans les champs & parmi les Bergers, a passé des hommes les plus simples aux esprits les plus sublimes. Imposante par la grandeur de son objet, curieuse par ses moyens de recherche, étonnante par le nombre & l'espece de ses découvertes, elle est peut-être la mesure de l'intelligence de l'homme, & la preuve de ce qu'il peut faire avec du tems & du génie. Ce n'est point qu'il ait trouvé ici la perfection qui lui est par-tout refusée; mais dans aucun genre l'esprit humain n'a déployé plus de ressources, ni montré plus de sagacité. Il est intéressant de se transporter aux tems où cette science a commencé, de voir comment les découvertes se sont enchaînées, comment les erreurs se sont mêlées aux vérités, en ont retardé la connoissance & les progrès; & après avoir suivi tous les tems, parcouru tous les climats, de contempler enfin l'édifice fondé sur les travaux de tous les siécles & de tous les peuples.

And again, from the first page of Livre Premier, we quote in translation:

> Most of the sciences have been born from the needs of man, Astronomy is due only to his curiosity. The apportionment of land has produced geometry; wealth and commerce have made arithmetic necessary; the transport of loads and architecture have demanded mechanics; injuries and illnesses have required recognition of medicinal plants, of the structure of the human body, and thus have been born botany, anatomy, and medicine. Everywhere man has called his industry to the aid of his weakness; everywhere need has drawn him from his natural slothfulness. Here alone as the spectacle of the heavens has drawn his interest he has not been pressed by the spur of necessity. Struck with admiration.

he has fallen into a profound reverie, he has followed tranquilly, and without effort, the course of the ideas which have presented themselves to his intellect. While around him on the earth everything moves with noise, movement accompanied by silence has instilled in him reverence; the uniformity of movement which unceasingly reappears again the same, has given him the idea of an order immutable and eternal; the particular movements of the heavenly bodies which are accomplished simultaneously without injury to one another, and which are not destroyed although opposite in general movement, announce to him a profound wisdom, which has regulated all by laws always fulfilled; he has felt the presence of the Supreme Being, and he has wished to understand the more to admire. Also while the other sciences have taken birth in the middle of the tumult of cities, this one has been born in the heart of the country. It is the science of repose, of solitude and of self-contentment. Troubled men, agitated by passions, would not have fathomed it, or would have disdained it as useless. It is due to simple men, whose free soul, without desire, without design for the future, having no need to concentrate on itself, can be lavished abroad; and these simple men, in watching over their flocks, have founded that one of all the sciences which the human spirit should one day enlarge the more.

Such is the description of astronomy as Bailly fashioned it nearly two centuries ago, a beautiful description, and one which we twentieth century astronomers are still trying to impress upon the non-astronomical public.

By contrast, Bailly expresses his opinion of astrology in no uncertain terms. We translate from the preliminary discourse of the same work, p. XII, calling special attention to two statements of great irony in this paragraph. The first is when Bailly says, "If the future should open before him, his existence would become only a burden." In view of his tragic death on the guillotine, this statement of Bailly's opinion of the future is dramatic. The second statement is his comment that the evils of astrology rule still in certain countries where the light of science has not penetrated. When we consider the volume of astrological literature that is flooding this continent two hundred years after Bailly, we can see that astronomy has not made as great progress in the public mind as could be wished.

Judicial astrology is a malady of the human spirit not less deplorable. It is born without doubt from abuse of astronomy. Everyone, impatient to look into the future, wishes at least to know what awaits him; the sage alone knows that this knowledge would be deadly. Unfortunate in the past, discontented with the present, man lives only by hope. The uncertainty of his destiny sustains him in a course that he exerts himself to accelerate. If the future should open before him, distressed by bad prospects become things of the present, not very sensitive to good things used before their possession, his existence would become only a

burden. Divine wisdom has spared us these evils that Astrology has wished to spread over the earth. They rule still in certain countries where the light of the sciences has not penetrated. In Europe even, it was not long ago that the people had their soothsayers and the princes their astrologers. Catherine de Medici, given over to this error, had constructed the column of the Hotel de Soissons, to consult the stars there; for the evildoers especially desire to know the future, and the reproaches of their conscience are a certain astrology against which they have need of being reassured. The death of Henry IV was predicted on all sides, both before and after this unfortunate event. Let us tell that the celebrated Jean-Dominique Cassini was given to astronomy by this very taste for astrology. He was soon undeceived, and his works, in spreading the light, have undeceived his century. The profound knowledge of the movement of the heavenly bodies has opened all eyes. The recognized distance of the stars has shown that they are too far away to shed their influences on our globe. Further, these bodies which, by the diurnal motion of the earth, seem to turn every day about us, ought to act every day in the same manner. They are thus insufficient to explain or to announce the diversity of characters, of passions, and of destinies. We have seen that their aspects, their encounters, determined for all eternity by invariable motions, announce nothing to mankind, that their spheres separated from ours by immense intervals, forbid all communication, all emanation; if it is not that of light, which is without doubt the same for all the stars, and which besides falls equally on all mankind.

In 1777 Bailly made the acquaintance of the famous Benjamin Franklin, and, for two brilliant minds, their first interview seems curious in the extreme. We translate the account given by St. A. Berville, *op. cit.*, which is similar to that given by Arago.

Among the commissioners was Franklin, celebrated in the history of the sciences and in the history of liberty. Franklin was acquainted with Bailly; their acquaintanceship had begun in a very singular manner. Bailly had a country home at Chaillot; it was there that he often retired to work in freedom. Chance also brought to Chaillot the American philosopher. Bailly, learning of his arrival, hastened to call upon him. He entered the home of Franklin, who knew him by reputation, and who received him with the most cordial air.

"Bonjour, Monsieur Franklin; comment vous portez-vous?"

"Fort bien, Monsieur."

After these first words, Bailly seated himself beside Franklin, and, afraid of being indiscreet in addressing a second question to him, waited until his host began to speak. Franklin, silent by nature, more silent still in his rank of ambassador, did not open his mouth. After a silence sufficiently long, Bailly, to begin the conversation, offered Franklin a pinch of snuff; Franklin made a wave of the hand that he did not take any. This silent interview lasted about two hours: at last, Bailly arose, Franklin accompanied him to the door, shook his hand as he repeated the single words: *fort bien*. Such was the origin of the acquaintanceship of these two celebrated men. Bailly loved to recall this anecdote and said often that *fort bien* were the only words that he had ever obtained from Franklin, when he found himself in a private interview with him.

To be continued.

NOTES AND QUERIES

Detonating Fireball in the Bruce Peninsula

On Sunday, April 3, at about 8.37 p.m. E.S.T. a spectacular fireball was seen in many parts of Ontario. By press and radio people were asked to report their observations of this phenomenon to the David Dunlap Observatory. As a result, observations were received from nearly every part of Ontario and a few from Quebec and Michigan. Many reports were also received at the Hume Cronyn Observatory in London, and these were kindly passed on to the D.D.O. by Dr. H. R. Kingston. It was soon clear that the fireball had occurred in the neighbourhood of the Bruce Peninsula, and the present writer made a trip to those parts to collect some first-hand accounts. In the region of Port Elgin and Wiarton the appearance of the fireball was followed by loud staccato reports and rumblings which rattled windows and shook the ground. The end of the path of the meteor appears to have been over Lake Huron near the Bruce Peninsula, and it appears likely that the possible meteorite which survived the flight through the atmosphere fell in the lake.

A fuller account of this fireball will appear in a later number of the Journal.

J. F. Heard

Sky Survey

Some 2,000 pictures of the heavens, which will provide the world with its most detailed Sky Atlas, will be taken by the 48-inch Schmidt Telescope which is along-side the 200-inch reflector on Palomar Mountain, California. This project is sponsored by the National Geographic Society, and the Mt. Wilson-Palomar Obser-

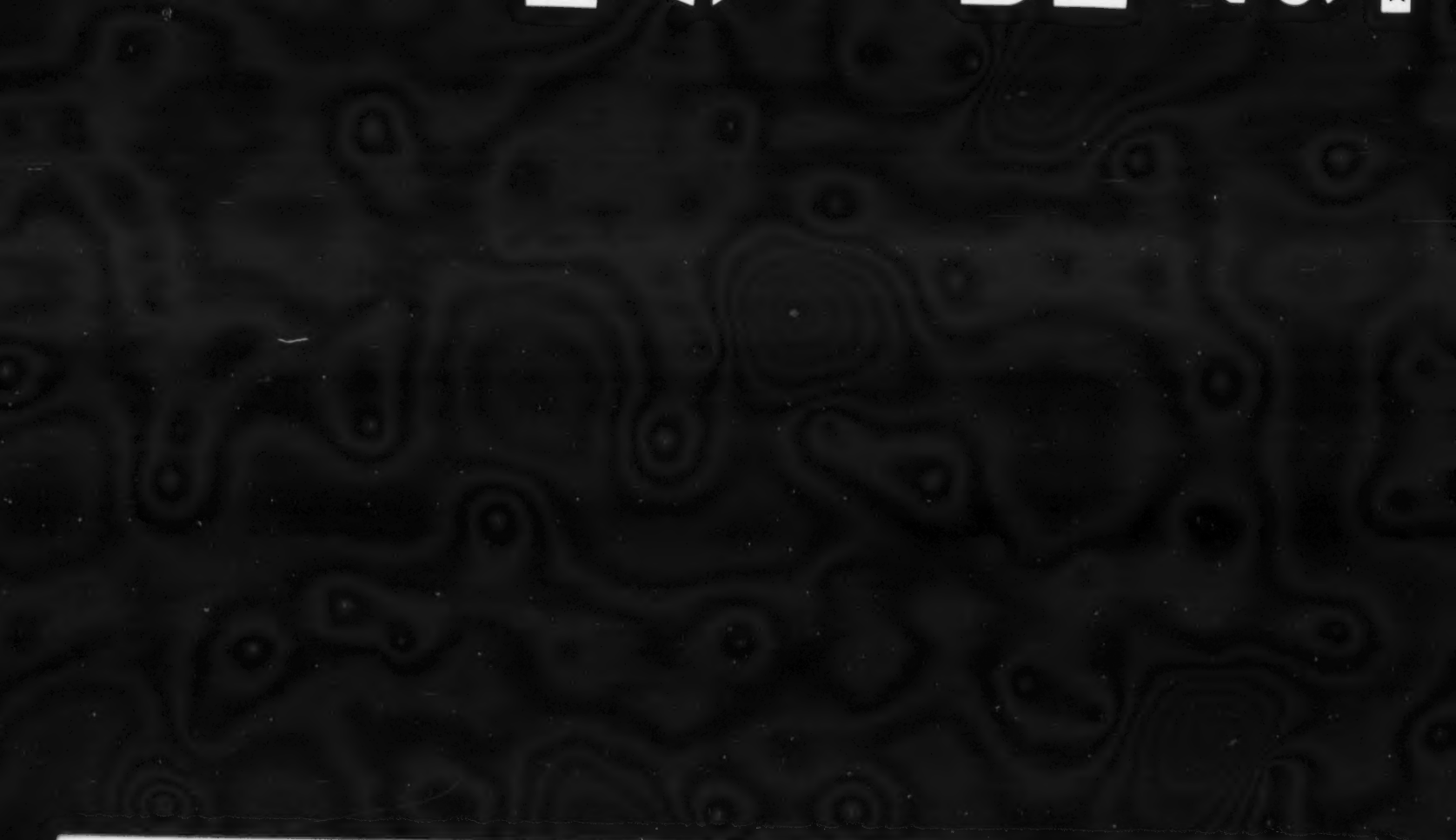


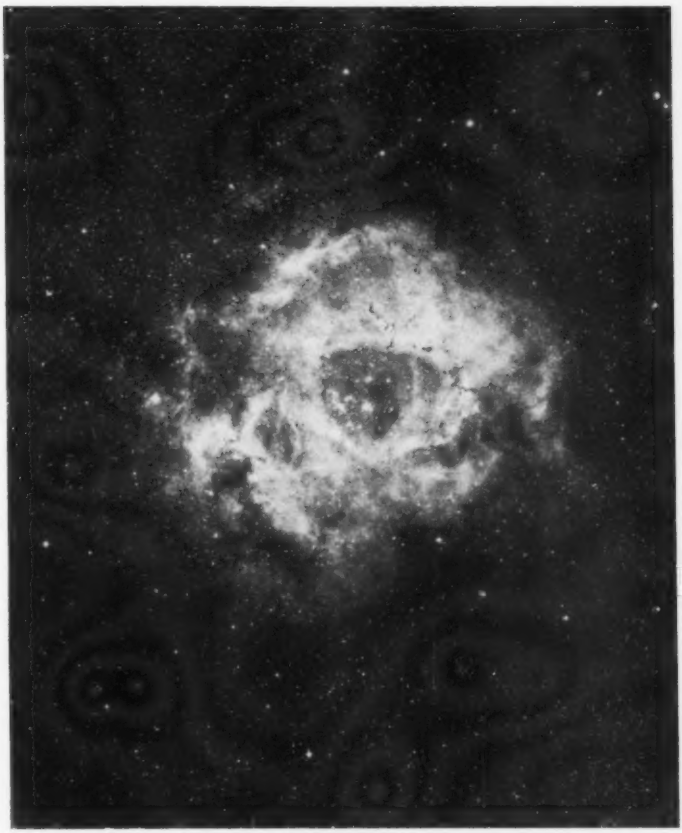
PLATE III

SET FOR SKY SURVEY

Dr. Edwin P. Hubble, dean of American astronomers, puts the unique 48-inch Schmidt photographic telescope through its final series of rehearsals for the National Geographic Society-Palomar Observatory Sky Survey, to be launched July 1. This four-year scientific project will provide the world with the first definite photo atlas of the heavens in mankind's history. The "Big Schmidt" is the sky-searching teammate of the 200-inch Hale telescope at the famed observatory atop Palomar Mountain in Southern California.

Journal of the Royal Astronomical Society of Canada, 1949

PLATE IV



MILKY WAY FRAGMENT

This is an enlargement of a small section of a test run photo made by the "Big Schmidt" photographic telescope, to be used in the National Geographic Society-Palomar Observatory Sky Survey, starting July 1. It shows a portion of the Milky Way in the constellation of Monoceros. This particular nebula is actually a cloud of dust and gas illuminated by nearby stars. Often referred to as the Rosette Nebula, it is known to astronomers as NGC 2237.

vatories, which will carry out the programme. The job will require four years to complete. Plates III and IV show a view of the 48-inch Schmidt, and a portion of a plate made with this instrument.

When the work is finished in 1953, a photographic map of three-fourths of the sky out to an average of 300,000,000 light-years will have been obtained, and will be known as the National Geographic Society-Palomar Observatory Sky Atlas. Copies of the atlas will be made available to other institutions and observatories throughtout the world at cost, which is estimated to be about $2,000 each.

C. A. C.

Perfecting the 200-inch Mirror

As is well known, the mirror of the great telescope on Mount Palomar, when practically tested by photographing the stars, was found to have slight imperfections, and efforts were immediately begun to correct them. As there is great interest everywhere in this instrument the following statement of just what is being done is taken from an account supplied by the director of the observatory to a local newspaper writer.

A series of test star photographs were taken with the light partly cut by a knife-edge. These may be called focograms; they indicate the location and approximate magnitude of the imperfection, say the surface there is ten millionths of an inch too high. Then the skilled optical worker starts to remove some twenty millionths of an inch of glass from the area indicated. He uses power-driven polishing laps up to 18 inches in diameter and hand laps from one to 2½ inches in diameter. These tools are aluminum discs covered by a layer of hard pitch, channelled and charged with cerium oxide. He rubs with straight strokes continually varying their direction. In any one rubbing operation only half a tea cup of the cerium oxide water mixture is used, and after the rubbing the polishing material is removed by sponges.

Then the mirror is put back in the telescope and star tests are made again. In each test 32 focograms are taken. The endeavour is being made to rub off one-half the amount required, then to rub off

one half of what is left, and so on until practical perfection is attained. Great care is being taken not to remove too much.

Six months is an estimate of the time required to complete the job.

C. A. C.

L'ASTRONOMIE

"Coeli enarrant gloriam Dei" (Ps. XVIII, v. 2.)

L'astronomie est la plus belle, la plus noble, la plus ancienne, la plus exacte des sciences humaines. Sa profondeur nous extasie et sa grandeur élève nos esprits jusqu'à l'Infini.

Les plus illustres génies l'ont connue, aimée et vénérée. Pour moi, humble atome de ce vaste univers, elle est à l'origine de ma vie intellectuelle et c'est grâce à elle si j'ai pu m'élever au-dessus des futilités, des bassesses, des vulgarités et des vanités d'ici-bas. C'est grâce à cette science profonde, si j'ai pu aimer, comprendre et admirer les splendeurs du ciel.

Comme les Mages et les philosophes de l'antiquité, comme les savants du Moyen-Age et les poètes modernes, je te salue O Astronomie! La plus sublime et la plus merveilleuse des Sciences.

Joseph Edgar Guimont,
Montréal, Qué.

MEETINGS OF THE SOCIETY

AT MONTREAL

Observation of Total Lunar Eclipse on April 12-13, 1949

A group of over twenty members of the Centre was organized to observe the eclipse from the Observatory, 4052 Wilson Avenue in Notre Dame de Grace, Montreal. In addition several smaller groups in various parts of the city co-operated in the programme of observation. Unless otherwise stated, the observations reported below were made at the Observatory.

Time Signals and Timekeeping. For observations that required accurate timing, stop-watches were used and the system developed on this occasion proved the most satisfactory to date. W. H. Birtles, as Recorder, assisted by C. N. S. Yarnell, had at his disposal five stop-watches which were numbered and labelled. Each watch was started on short-wave time signal from the U.S. Bureau of Standards, checked for error and the time recorded. The watch was handed to the observer who stopped it when the phenomenon occurred and returned it to the recorder who made the necessary computations. The watch was then re-set and ready for use again.

A master-clock, checked periodically to time signals, was used to synchronize all other observations. Timekeepers Mrs. J. Wright and Mrs. D. Zorgo were on duty from 8.40 p.m. to 1.00 a.m., calling the time at five minute intervals and also giving the time to any observer on request. All times thus called were recorded and this proved a most useful record for confirming and cross-checking observations later.

All times given in the following reports are Eastern Standard Time.

Weather Report. To one member, Frank Kvetan, was assigned the task of keeping a detailed report of weather conditions, recording any cloud formations in the vicinity of the moon. This record also proved useful for cross-reference purposes.

Contacts. Temporary clouds interfered with timing of the first contact at the Observatory. The earliest moment at which contact could be confirmed is shown below with the times of the other three contacts.

Observer:	Paul S. Scott	C. M. Good
Equipment:	6-in. Refr. 45x	4-in. Refr. 75x
1st Contact Confirmed	9 hrs. 39.09m.	9 hrs. 39.49m.
2nd Contact	10 hrs. 27.96	10 hrs. 27.95
3rd Contact	11 hrs. 54.15	11 hrs. 53.82
4th Contact	12 hrs. 54.14	12 hrs. 54.00

Timing of Lunar Features

Crater	*Time*	*Observer*	*Equipment*
Eratosthenes	Im. 9h.56m. 9s.	D. Garneau	12″ Refl. 80x
Eratosthenes	Em. 12h.16m.41s.	D. Garneau	12″ Refl. 80x
Atlas	Im. 10h.23m.29s.	D. Garneau	12″ Refl. 80x
Linne	Im. 10h. 8m.39s.	D. Garneau	12″ Refl. 80x
Plato	Im. 10h. 9m.34s.	F. DeKinder	4″ Refr. 140x

This information was specifically requested by Walter H. Haas.

Stars Visible during Totality. To several members was assigned the task of plotting the stars in the constellation of Virgo that became visible during the period of totality. These charts were later checked to star atlases to determine the magnitudes. R. de Repentigny plotted stars to 5.5 mag. He also noted that 4th mag. stars became visible at 9.55 p.m. and 5th mag. as early as 10.15 p.m. before totality began. T. Noseworthy also plotted stars to 5.5 magnitude. At Sault-au-Recollet, F. DeKinder and G. Harper Hall recorded stars to 5th magnitude. At St. Lambert, away from much of the city glare, Mrs. A. R. MacLennan and E. A. Maize plotted stars to 5.5 mag. and reported that they could see numerous other ones that were just a little too faint to plot accurately. Dr. W. L. Orr in Notre Dame de Grace reported that Alcor was seen easily at 10.26 p.m. He also reports that stars in the vicinity of the moon and Spica which became visible during totality had disappeared again by 12.10 a.m.

Meteoritic and/or Impact Flares. Only negative reports were received from our observers who were concentrating on observation of possible meteoritic and/or impact flares on the moon's surface during totality. E. E. Bridgen and D. E. Douglas, using the 12-in. reflector, with 80 power, observed from 10.35 p.m. to 11.53 p.m. with one-minute break periods at 10.50, 11.10, 11.30 while observers changed place. Mrs. F. Hall and H. Newman, using a 5-in. reflector, 35x, observed from 10.30 p.m. to 11.54 p.m. with a one-minute break a 11 o'clock. In St. Lambert, A. R. MacLennan observed with his 70mm. refractor, 40x from 10.28 p.m. to 11 o'clock but saw nothing to report. W. E. Leeson, in the town of Mount Royal, made observations at intervals with his 2¾-in. refractor but saw nothing to indicate meteors. Dr. W. L. Orr, from his home in Notre Dame de Grace, also observed with his 6-in reflector, 65 power, from 11.08 p.m. to 11.26 p.m.

This programme also was conducted under instructions from Walter H. Haas.

Colour Changes. Mr. and Mrs. F. Baader and Miss MacCallum made continuous observations of colour changes from 9.00 p.m. to 1.00 a.m. Observations for shorter periods were made by G. Bloom, Mrs. M. de Maurivez, Ross H. Ford, H. MacDonald, O. Lingeman and Mrs. F. Skelton. Reports were received also from Robert Pringle at Valois,, W. L. Orr, in Notre Dame de Grace, A. R. MacLennan in St. Lambert, F. DeKinder and G. Harper Hall at Sault-au-Recollet and W. E. Leeson in town of Mount Royal. Many of the

reports included drawings of conspicuous areas. Observers in all locations used the word "copper" to describe colour in the shadowed portion. Some reported copper tones as early as 9.44 p.m. and all were agreed that the colour was present by 10 o'clock. The shift in colour and light intensity was was recorded in detail by many of the observers.

Changes in Lunar Features. DeLisle Garneau, using 80 power on the 12-in. reflector, concentrated on possible changes in lunar features following the period of totality, observing particularly the three craters Atlas, Linne and Eratosthenes. His report includes drawings of all three areas before and after totality and indicates definite changes in both Altas and Eratosthenes.

F. DeKinder, at Sault-au-Recollet, attempted similar work with his 4-in. refractor but found that he could see insufficient detail to make any comparison possible.

Occulation during Totality. At exactly 10h.34.27 m., Paul S. Scott, using 45 power of the 6-in. refractor, clocked the occultation of a faint star. It appeared to be of 7th or 8th magnitude but must have been below 7.5 mag. since it could not be identified later by reference to the British Nautical Almanac which only lists occultations to 7.5 mag. Mrs. F. Hall, who was observing at her 5-in. reflector, reports the immersion at approximately 10h.34m.39s. Mr. Scott timed the emersion at 11h.44.18m. The emersion was also reported by Dr. Orr at approximately 11.44 p.m. Dr. Orr reported the emersion of another faint star, probably of 9th magnitude, at approximately 11.48 p.m.

Bright Meteor. A bright meteor in the vicinity of the moon during the period of totality attracted the attention of many observers and was recorded by the following. R. De Repentigny describes it as "a bright meteor, green, no tail, tear-shaped, of —2 magnitude at point slightly above moon, diminishing to nothing about 7 degrees above horizon." Tom Noseworthy clocked it at 10h.53m.40s., with a possible lag of a couple of seconds, and plotted it as above and slightly to the east of Iota Virginis, travelling to below and to east of Spica. A. R. MacLennan, in St. Iambert, reports it as 10.54 p.m. and as being at least twice as bright as Sirius.

Aurora Display. A spectacular display of the aurora borealis was witnessed during the period of totality. It was recorded by R. Venor, Mrs. J. Wright and Miss I. K. Williamson, from 10.53 p.m. until 12.20 a.m. W. E. Leeson reported indications of aurora as early at 9.36 p.m. F. DeKinder and G. Harper Hall observed it at Sault-au-Recollet from 10.40 p.m. until midnight. Dr. Orr reported it at 11.08 p.m. Robert Pringle at Valois sent in a report also.

Detailed reports of the observations covered by this summary have been sent to the following:

Walter H. Haas, University of New Mexico, Albuquerque, N.M. Weather report, Timing of Contacts, Timing of Lunar Features, Stars Visible during Totality, Meteoritic and/or Impact Flares, Colour Changes and Changes in Lunar Features.

Dr. Alice Farnsworth, Mount Holyoke College, South Hadley, Mass. Report of occultations.

Dr. Peter M. Millman, Dominion Observatory, Ottawa, Ont. Report of meteor.

Dr. C. W. Gartlein, Cornell University, Ithaca, N.Y. Reports of aurora borealis.

ISABEL K. WILLIAMSON,
Recording Secretary.

AT TORONTO

October 12, 1948.—The first regular meeting of the Toronto centre met at the Dunlap Observatory as the guests of the Observatory staff. Owing to cloudiness, the activities were confined to an inspection and explanations of the Observatory Instruments, and to the proceedings in the lecture room. The chief item here was a talk by Dr. C. A. Chant on the great British Astronomer, Sir Wm. Herschel. The presence at this meeting of one of Sir William's direct descendants (Mrs. Stone) added interest to the occasion. Dr. Chant, in an interesting, intimate way, showed the varied qualification for greatness possessed by Herschel, his helpful human nature, his surpassing industry and capacity, first in respect to long years as a musician, then as a student of astronomy and a maker of telescopes, a series of which he made, the greatest being a 40-foot instrument. He was outstanding in the illuminating interpretations he gave to his observations with the aid of these.

November 2 and 30, 1948.—These were members' nights arranged to promote a more intimate sort of member-participating procedure.

A considerable number of pictures of sky phenomena had been posted about the room before the meeting and these were examined informally by the members who were asked to write down the proper name for each. The answers were given after due time, by the chairman, each person checking his own.

This was a sort of quizz number and was followed by another type later, which was conducted by a director giving questions or problems of astronomical significance in turn, to the individuals of two contesting teams which had been chosen. In addition to the answers, other comments and explanations were added by any member, as occasion seemed to call for it. The younger members in particular were the more alert to this procedure.

November 16, 1948.—The Toronto Centre, on this date, heard Mr. Paul H. Serson of the Dominion Observatory, Ottawa, give an account of the expedition that he and some of his associates, made last year into the North Polar region to discover the changes that had occurred in recent years in respect to the shifting magnetic North Pole. The data they gathered indicate that it had shifted about 200 miles northward in the last fifty years. The Dominion Observatory, since then, has been taking steps to verify this and to prepare new maps and charts for the guidance of ships, planes and others travelling or living in those northern regions.

JOHN R. TUCK, *Recorder.*

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